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PRESENTATION OF THE NOBEL PRIZE TO PROFESSOR ERNEST O. LAWRENCE[1]

By Professor RAYMOND T. BIRGE

UNIVERSITY OF CALIFORNIA

Mr. President, Mr. Consul-General, Dr. Lawrence, Ladies and Gentlemen:

South Dakota was admitted to the Union in 1889. It is thus a very young state, and one need not be surprised that as yet relatively few of its native sons have achieved great distinction. One of these few is Ernest Orlando Lawrence, who was born in Canton, S. D., on August 8, 1901. Ernest's father, Carl G. Lawrence, is now president emeritus of Northern State Teachers College, Aberdeen, S. D., and is living in Berkeley with his wife. The father of Carl Lawrence was Ole Lawrence, another school teacher, who, as an immigrant from Norway, settled at Madison, Wis., in the year 1840. Ernest's maternal grandfather, Erik Jacobson, also an immigrant from Norway, was a South Dakota pioneer.

Ernest Lawrence is the first native of South Dakota to be elected to membership in the National Academy of Sciences, an honor that came to him in April, 1934, when he was only 32 years old. He is now the first native of South Dakota to become a Nobel Laureate. By an interesting coincidence, one of Dr. Lawrence's intimate boyhood friends, Dr. Merle A. Tuve, is at present in charge of nuclear physics research at the Carnegie Institution of Washington, where a huge 60-inch cyclotron, similar to the large Berkeley cyclotron, is now under construction.

Dr. Lawrence obtained his elementary education in the public schools of Canton and Pierre, S. D., and did his undergraduate college work first at St. Olaf Col-

[1] Address at the Nobel Prize presentation, February 29, 1940.

lege and then at the University of South Dakota, where he was inspired by Dean Lewis E. Akeley to enter the field of physics. He undertook graduate work at the University of Minnesota, the University of Chicago and finally at Yale University, where he obtained his Ph.D. degree in 1925. At Minnesota he came under the influence of Dr. W. F. G. Swann, now director of the Bartol Research Foundation, Swarthmore, Pa., and an authority in the field of cosmic rays. This influence, which was profound, explains the transfers of Dr. Lawrence from one university to another, for they coincided precisely with similar transfers on the part of Dr. Swann.

After receiving his doctor's degree Lawrence remained at Yale, first as a National Research Fellow and then as an assistant professor. When Swann left Yale to become director of the Bartol Foundation, the University of California seized the opportunity to secure the services of a man who already was recognized as one of the most brilliant young physicists in the country. The University of California, after 12 years, still retains his services, in spite of numerous enticing offers that he has received from elsewhere.

The first published scientific paper by Dr. Lawrence is dated May, 1924. In the succeeding 16 years his name has appeared on 56 papers, an average of just three and one-half papers a year. This in itself is a remarkable record, but what is more remarkable is the number of papers by his students and associates—papers that do not bear his name, but that carry only too plainly the impress of his guidance and inspiration. His first paper, entitled "The Charging Effect Produced by the Rotation of a Prolate Iron Spheroid in a Uniform Magnetic Field," contains no trace of his future interests. One of these interests, however, appears in his doctor's thesis, which lay in the field of photoelectricity. Further work in this field was carried out both at Yale and at California. In fact, Dr. Lawrence's first Ph.D. student, N. E. Edlefsen, did his thesis in this field. We shall hear of Dr. Edlefsen again.

From the start of his scientific career, Dr. Lawrence showed an exceptional breadth of interest. While a National Research Fellow at Yale he measured the ionization potential of the mercury atom. This was, at the time, the most precise determination of its nature that had ever been made. Its importance is due to the fact that the result enables one to calculate the value of the so-called Planck constant, h, one of the four most important universal constants of nature, and the fundamental constant of the quantum theory. There is, however, another point of interest in this research. The ionization potential of the mercury atom is merely the energy required to tear an electron loose from a neutral mercury atom. Now the word "atom," as all of you know, means something that can not be divided, although, as all of you also know, carving up atoms into little bits is at present the favorite pastime of physicists. Hence when Lawrence thus pried loose an electron from a mercury atom and measured precisely the energy required to do this, he in one sense disintegrated the atom. But it takes only a relatively trifling amount of energy—some ten volts in the case of mercury—to remove one of these so-called external electrons from an atom, and nowadays we reserve the name disintegration for a process by which the nucleus of the atom is in some way changed, the resulting atom having, in general, completely different chemical properties and being, in fact, a different element. Such a disintegration requires energy equal to millions, rather than tens of volts to bring about, and it is the discovery of a practical method for obtaining by artificial means such high energies that has brought Dr. Lawrence his present fame.

Before, however, Lawrence had settled down to atom smashing in a serious way, he did other interesting things. One of these was the development, in cooperation with Dr. J. W. Beams, of a successful method for obtaining time intervals as small as three billionths of a second. After he came to California, Lawrence and his students applied this method, which involves the use of a Kerr Cell, to a study of the phenomena occurring in the early stages of the discharge of an electric spark. Since a single spark lasts for only about one millionth of a second, it is obvious that an extremely short "exposure" must be used to photograph the details of its development.

Another of Dr. Lawrence's inventions—if you wish to apply that term—was a new and very precise method for measuring e/m, the ratio of the charge to the mass of an electron. This ratio is another of the fundamental constants of nature. The detailed development of the method was carried out by one of his students, Dr. F. G. Dunnington, whose final result is possibly our present most accurate value of this important constant. So much for the work of Dr. Lawrence outside the field of atomic disintegration. The picture has been sketchy; yet I hope it has indicated the versatility of his ideas.

Then one evening almost exactly ten years ago to-day, Dr. Lawrence happened to glance at an article which had just appeared, by a German physicist, R. Wideroe. He did not actually read the article, but his attention was drawn to a diagram of the apparatus. With this apparatus, Wideroe, by the use of a 25,000 volt potential drop, had succeeded in imparting to atoms of potassium energy equal to that resulting from a 50,000 volt drop. As a matter of fact the particular idea used by Wideroe was not new—it had been suggested ten years earlier—but Wideroe was the first one to apply it successfully. Now Lawrence

had for some time realized the growing importance of the field of nuclear physics, and had been looking for ways and means of successful experimentation in the field. This paper by Wideroe immediately suggested to him the general idea of producing the very high energy particles required for atomic disintegration, by means of a succession of properly timed "pushes," each of which might be relatively small. Then and there he began sketching various ways of carrying out this idea. Wideroe had used two hollow cylinders, lined up on the same axis. Lawrence sketched a series of such cylinders, but in the case of atoms of small mass, which are most effective in nuclear disintegration, the necessary length of the apparatus would then be too great. He next thought of the possibility of using a curved path. Now an electrically charged particle, entering into a magnetic field directed at right angles to the motion of the particle, proceeds to move in a circle with constant speed. Moreover, the time to move through a half circle depends only on the charge and mass of the particle and on the strength of the magnetic field. It does not depend on the speed of the particle. The greater the speed, the greater the radius of the circle in which the particle moves. This important fact, which Dr. Lawrence immediately noted by writing down a very simple mathematical relation, gave him the idea of the present essential features of the cyclotron. All this happened within a few minutes of the time he had seen Wideroe's paper. The next morning Dr. Lawrence told his friends that he had found a method for obtaining particles of very high energy, without the use of any high voltage. The idea was surprisingly simple and in principle quite correct—every one admitted that. Yet every one said, in effect, "Don't forget that having an idea and making it work are two very different things."

It seems to me that, in this connection, I can quote with profit some remarks made by Dr. W. D. Coolidge, director of the Research Laboratory of the General Electric Company, when he presented to Dr. Lawrence, in 1937, the Comstock Prize of the National Academy of Sciences. This prize, awarded only once in five years, is considered the greatest honor at the bestowal of the Academy. Dr. Coolidge first sketched the classical experiment of Lord Rutherford, in 1919, when by using the alpha particles ejected by a radioactive substance, he succeeded in changing nitrogen into a form of oxygen. This was the first true disintegration of matter produced by man, and as such, an experiment of epoch-making importance. As Dr. Coolidge notes, Rutherford succeeded in thus breaking up nitrogen and other light atoms, but to disintegrate heavy atoms, particles of still greater energy appeared to be needed. Such high-energy particles, to use as bombarding projectiles, could obviously be produced artificially, by allowing charged particles to fall through sufficiently high voltages. There would be, however, great difficulties in developing tubes to withstand such voltages. Dr. Coolidge then goes on to say:

> Dr. Lawrence envisioned a radically different course—one which did not have those difficulties attendant upon the use of potential differences of millions of volts. At the start, however, it presented other difficulties and many uncertainties, and it is interesting to speculate on whether an older man, having had the same vision, would have ever attained its actual embodiment and successful conclusion. It called for boldness and faith and persistence to a degree rarely matched.

That is the end of the quotation. Those who have worked with Dr. Lawrence during these past ten eventful years can well testify that it did indeed call for "boldness and faith and persistence to a degree rarely matched." The story of the development of the cyclotron reads like a fairy tale. To be told properly, many hours would be required.

But we are living in a practical world, and it is the results actually achieved by the use of the cyclotron, rather than the details of its development, that have caught the attention of every one, scientists and non-scientists alike. This fact was recognized by the Nobel Committee, when it awarded the prize to Dr. Lawrence with the citation—"for the invention and development of the cyclotron and especially for the results attained by means of this device in the production of artificial radioactive elements."

It is important to note at this juncture that the cyclotron was not the only method devised by Professor Lawrence for the production of high energy particles without the use of high voltages. Another method, already mentioned, employs a series of cylinders set on a common axis. Such a devise, called by Lawrence a "linear resonance accelerator," was actually constructed and used by him and several of his students for accelerating *heavy* particles to high energies. I have already noted that an apparatus of this type is not suitable for light particles, because of the required size. Still a third piece of apparatus, the double linear accelerator—a modification of David Sloan's remarkable x-ray tube—was tested at considerable length. The cyclotron, however, finally proved superior to any other device, and it is only because of this fact that eventually these other methods were dropped, and all attention concentrated on the cyclotron. Even as late as 1934 Lawrence believed that the double linear accelerator would surpass the cyclotron in its yield of neutrons, but such proved not to be the case. The cyclotron is thus not a lucky accident, but a piece of apparatus that has, after detailed development, finally proved its superiority to several other methods of attack devised by Dr. Lawrence.

The first cyclotron, only four inches in diameter,

was constructed of glass and red sealing wax, in January, 1930, by Lawrence and Edlefsen, who, as previously noted, was Lawrence's first Ph.D. student at California. Actual resonance effects were obtained, and the first public announcement of the new method was made by Lawrence and Edlefsen at the meeting of the National Academy of Sciences at Berkeley, in September, 1930. A metal cyclotron of the same size was then constructed by Lawrence and M. S. Livingston, who was prominently identified with the development of the cyclotron during the next few years. With this almost toy-like instrument, as viewed in retrospect, a beam of hydrogen molecular ions was generated, whose energy corresponded to that produced by 80,000 volts, although the highest potential difference in the instrument was only 2,000 volts.

Spurred by his success, Lawrence next built an eleven-inch cyclotron. This instrument cost $1,000, plus some borrowed equipment. With it one and one quarter million volt hydrogen ions were obtained, the most energetic beam of particles ever produced in the laboratory up to that time. This beam of ions was used, during the summer of 1932, to disintegrate lithium, the first artificial disintegration of matter to be carried out in the western hemisphere. That year, 1932, was by all odds the most exciting in the history of modern physics. During it heavy hydrogen was discovered by H. C. Urey at Columbia University, the neutron was discovered by James Chadwick at the Cavendish Laboratory in England, and the positive electron, or positron as it is usually called, was discovered by C. D. Anderson at the California Institute of Technology. Each of these discoveries was later honored by a Nobel Award.

The University of California is especially interested in heavy hydrogen, for not only did Urey get his doctor's degree at Berkeley, but the existence of heavy hydrogen was predicted here, and after its discovery, G. N. Lewis was the first person to obtain it in high concentration. Samples of highly concentrated heavy hydrogen were then generously supplied for research work in all parts of the world. But nowhere did this new material prove more useful than right here in Berkeley. Employed as a bombarding projectile in the cyclotron, heavy hydrogen or deuterium, as it is now called, was found to be extraordinarily effective in producing nuclear disintegrations. Furthermore, the cyclotron is by far the most efficient device for generating neutrons in relatively large quantities, and neutrons, in turn, cause many new types of nuclear disintegration. Thus the development of the cyclotron has not only paralleled important discoveries elsewhere, but the cyclotron itself has made possible perhaps the most important applications of these discoveries.

The last great discovery that has since played an important role in the usefulness of the cyclotron is that of artificially induced radioactivity. This discovery was made by F. Joliot and his wife, Irene Joliot Curie, at Paris, in January, 1934. Again a Nobel Award promptly resulted.

But let us return to the development of the cyclotron. Although million-volt hydrogen ions had proved sufficient to disintegrate the light lithium atom, it was well known, as stated in the quotation from the presentation address by Dr. Coolidge, that much higher energies would be needed in order to disintegrate heavier elements. To produce particles of these higher energies, a cyclotron far larger than an eleven-inch instrument was obviously necessary. The figure, eleven inches, refers to the diameter of the vacuum chamber in which the ions revolve in circles of ever-increasing radius, until finally they are removed through a special port-hole in the wall of the chamber. Since this spiraling movement is produced by a uniform magnetic field, it is necessary that the pole faces of the magnet be at least as large as the diameter of the vacuum chamber. Now even the eleven-inch cyclotron employed one of the largest magnets then to be found in a scientific laboratory. Hence the construction of the much larger instrument now needed meant moving from the realm of physics into that of engineering; and that is just where most physicists would have stopped. Not so with Dr. Lawrence. He moved literally into the field of engineering, by appealing to our own Professor L. F. Fuller, at that time also vice-president of the Federal Telegraph Company. Dr. Fuller had just what Lawrence needed, a gigantic magnet built for a radio transmitter ordered by the Chinese government, but obsolete in type before delivery was possible. Thus a "white elephant" to Dr. Fuller became a godsend to Dr. Lawrence. With this magnet as the basis, the first really large cyclotron was built during that eventful year, 1932. The diameter of the pole faces is 37 inches, but the actually used portion of the original vacuum chamber was only thirteen inches in diameter. Numerous engineering as well as scientific problems had to be solved before it was possible to employ completely a 37-inch chamber, as is being done at present. In fact only those directly associated with the work of the Radiation Laboratory can appreciate fully the innumerable difficulties that have arisen and have, one by one, been conquered. As I have already indicated, the present cyclotron is primarily the result not of a moment's inspiration but rather of years of perspiring effort. The 37-inch cyclotron is now installed in the old Radiation Laboratory. It weighs some 75 tons.

The present world's largest cyclotron is the 220-ton instrument, located in the new William H. Crocker Radiation Laboratory. The vacuum chamber is 60 inches in diameter, and it produces 100 microampere

currents of 16-million-volt deuterons. The beam, emerging into the air, has a diameter of a few inches, and penetrates some five feet. It is our nearest approach to a "death-ray." Just what is the constitution of such a beam? The heavy hydrogen nuclei composing it are moving, when they emerge from the cyclotron, with a speed of some 25,000 miles a second—about 13 per cent. of the velocity of light. The *number* of individual atoms, issuing from the cyclotron per second, is 600 million million! To obtain an equally dense beam of particles from radium would require something like *thirty tons* of pure radium, and even then the energy of the individual particles would not be nearly as great.

By causing the cyclotron beam to fall on a piece of beryllium, disintegration of the beryllium atoms is produced, accompanied by a copious emission of neutrons. These particles, equal in mass to the hydrogen atom, but with no electric charge, were produced originally by allowing the radiation from some natural radioactive substance, such as radium emanation, to fall on beryllium. To equal, in this way, the neutron yield of the cyclotron, some *200 pounds* of radium would be required—and radium costs nearly a million dollars an ounce! Thus the number of high energy particles produced by the cyclotron is of a completely different order of magnitude from that given by any other source. Herein lies the great practical value of the instrument.

When one turns more specifically to the uses of the cyclotron, the wealth of material is so great that it is difficult to know what to select for presentation, in the few remaining minutes at my disposal. It is doubtful if any scientific instrument invented by man has found more varied and more important applications. Lawrence originally designed the cyclotron in order to disintegrate atomic nuclei, and thus to gain information in regard to the structure of the atom. At the present time every element, without exception, has thus been disintegrated, a new element being in general produced. It one wants gold, Lawrence will take mercury and turn it into gold. But the process is far more costly than the value of the gold produced. In fact, the one great possibility of the cyclotron, as a money-making instrument, lies not in making gold, or platinum, or any other so-called precious substance, but in releasing nuclear energy. We now know that nearly all the energy of the universe is locked inside the nuclei of atoms, and we have found recently that even slowly moving neutrons have the ability to cause the nucleus of uranium to explode into two more or less equal parts. In this process some *200 million* electron volts of energy are released. To visualize this amount of energy, consider the fact that when an atom of carbon is burned to form carbon dioxide, about four electron volts of energy are released. As yet this uranium disintegration has not been developed into a self-sustaining process, such as is needed for the commercial production of energy. But with the far more energetic particles that Dr. Lawrence hopes to produce with a much larger cyclotron, other more suitable types of disintegration may well be found. The practical aspects of such an unlocking of nuclear energy, if it is accomplished, are so staggering that some of us shrink even from contemplating them.

With the cyclotron one can, as stated, transform every stable element into other forms. Some of the final products are themselves stable, but most of them are radioactive. The cyclotron is by far the best device for producing new radioactive substances. There are about 90 different elements, but most of these can exist in several different stable forms, known as isotopes. There are now some 386 known stable forms. In addition, there are about 335 artificially produced radioactive substances, of which 223 have been discovered by means of the cyclotron. More than half of the 223 have been found here at Berkeley. The remainder have been discovered by means of some one of the 21 cyclotrons now in operation at other institutions. An additional 17 cyclotrons are under construction. Directing or assisting in work of this kind at 25 different institutions are 47 men, trained for longer or shorter periods of time in the Berkeley laboratory.

Many of the artificially produced radioactive substances are proving of extraordinary value in medicine and in biology. Others are of great interest in themselves. I give just one illustration of the latter class. A few years ago it was believed that every element in the periodic table had been found, with the exception of the elements of atomic number 85 and 87, the hypothetical elements known as eka-iodine and eka-caesium, respectively. Then it became apparent that there was no valid evidence for the claimed existence of stable element 43, called masurium by its apparently deluded discoverer, nor for element 61, called illinium. Quite recently, Dr. Emilio Segrè, a member of the staff of the Radiation Laboratory, has definitely found a radioactive form of element 43, among the products produced by the cyclotron, and he has published several papers on this subject. I now have the privilege and the honor to make the first public announcement of another similar discovery. Dr. Dale Corson, a member of the Physics Department staff and of the Radiation Laboratory, aided by Dr. Segrè, Dr. J. G. Hamilton and Mr. K. R. MacKenzie, has found what appears to be clear evidence of a radioactive form of element 85, eka-iodine. All possible alternatives are not yet excluded, but the evidence is much stronger than that on which the announced discovery of several new elements has been based. Meanwhile the discovery of eka-caesium, element 87, has recently been announced

from Irene Joliot Curie's laboratory in Paris. That leaves only element 61 still missing, and there is a strong probability that a radioactive form of this element will be found among the disintegration products yielded by the cyclotron beam.

The great importance of radioactive elements in medicine and in biology results chiefly from their use as so-called "tracer atoms." One can, for instance, make a radioactive form of sodium that does not differ chemically from stable sodium. Taken through the mouth in the form of common salt, these radioactive atoms travel with surprising rapidity to various parts of the body. Any one such atom may exist for many hours, or only for a fraction of a second, but the average life of an atom of radio-sodium is about 21 hours. When it does die—by transformation into a new element—each atom gives unmistakable evidence of its location by ejecting a high-speed particle, which may be recorded with a so-called Geiger counter. Thus the wanderings of *single atoms* may be accurately followed in chemical and biological processes. The eminent physiologist, Professor A. V. Hill, has told Professor Lawrence that, in his opinion, the use of such tracer elements will be recorded in history as a technique of equal importance with the use of the microscope. Just because of these facts, chemists, biologists, cytologists, bacteriologists, physicians and radiologists —to make only an incomplete list—are now working with these products of the cyclotron, in close cooperation with the regular staff of the Radiation Laboratory. Samples of radioactive material are being supplied to at least twenty such groups, some located on the Berkeley campus and others at institutions all over the world.

I now, for the second time this evening, have the privilege of making a first announcement of very great importance. This news is less than 24 hours old, and hence is real news. Carbon, as you know, is the most important element in plants and animals. Hence a radioactive form of carbon, with a long average life, is the one radioactive substance most desired by chemists and biologists, for use as a tracer atom. A radioactive form of carbon, of mass 11 and average life 30 minutes, is now known and in spite of its comparatively short average life, has already made possible important conclusions relating to plant growth. Now Dr. S. Ruben, instructor in chemistry, and Dr. M. D. Kamen, research associate in the Radiation Laboratory, have found, by means of the cyclotron, a new radioactive form of carbon, probably of mass 14, and average life of the order of magnitude of several years. On the basis of its potential usefulness, this is certainly much the most important radioactive substance that has yet been created.

Radioactive elements are used not only as tracer atoms. They are now being used also in the direct treatment of various diseases, and the results in certain cases, such as chronic leukemia, are distinctly encouraging. Finally, the neutron rays produced by the cyclotron are found to have many applications in both biology and medicine, quite aside from their importance to physicists. They have already shown very promising possibilities in the treatment of cancer, and other medical uses are constantly being found. In the medical work of the Radiation Laboratory, Dr. Ernest Lawrence is fortunate in having the cooperation of his brother, Dr. John Lawrence, a medical scientist of great ability. Although I have neither the time nor the competence to discuss in detail these manifold uses of the cyclotron and its products, I hope that I have given at least a glimpse of their extent. Already 163 papers have been published from the Berkeley Radiation Laboratory itself, and 76 different names appear on these papers.

The progress of science is the progress of instruments. A scientific theory is meaningless unless it can be tested experimentally. Such a test normally requires an appropriate instrument, and thus, for the testing of theories as well as for the direct observation of facts, instruments are indispensable. One needs only think of what would remain of astronomy without the telescope or of biology without the microscope. The cyclotron is now playing a similar role in the infant field of nuclear physics. But the cyclotron, as noted, has a unique additional value, due to the fact that it manufactures, in relatively large amounts, various products, each of which is itself already of tremendous importance in widely varying fields. It is therefore a real tribute to refer to Dr. Lawrence as an eminent inventor. This idea has already been expressed in a beautifully worded editorial in the *New York Times,* a portion of which reads as follows:

> The pioneers in experimental physics have always had to devise their own instruments of investigation. Men like Faraday, Hertz and Helmholtz are not listed among the great inventors. For the servants of science invent as a matter of course, rarely take out patents, and concentrate on research. Who thinks of Hertz's simple detector of electric waves as the first wireless apparatus, or of the apparatus with which Faraday discovered electromagnetic induction as the germ of the electric generator and motor? If Professor Lawrence were what is called a "practical" inventor and his cyclotron were of any immediate commercial use, he would take his place beside Watt, Arkwright, Bell, Edison and Marconi, which would probably exasperate rather than flatter him.

That is the end of the quotation.

I can not close without commending the completely unselfish attitude of Dr. Lawrence toward his associates. This is well shown by his first remark on being informed of the Nobel Prize Award—namely, "It goes without saying that it is the laboratory that is honored,

and I share the honor with my co-workers past and present."

The development of the cyclotron has taken the united efforts of many most capable and willing workers, but it is the ability and the inspiration of Lawrence that have brought these workers together, and have held them together, in spite of every obstacle, until to-day the Radiation Laboratory represents as fine a piece of cooperative effort as exists in the annals of science. I therefore pay tribute to Dr. Lawrence not only as a scientist of real distinction, but as one who exemplifies the best in scientific ideals.

RESPONSE

By Dr. ERNEST O. LAWRENCE

PROFESSOR OF PHYSICS AND DIRECTOR OF THE RADIATION LABORATORY, UNIVERSITY OF CALIFORNIA

Mr. President, Mr. Consul-General, Professor Birge, Ladies and Gentlemen:

WORDS fail me in giving expression to my thoughts on this occasion. To convey to you, Mr. Consul-General, and through you to the Royal Swedish Academy of Science my profound gratitude for this great honor would be giving expression to only a part of what is in my mind; for I am mindful that scientific achievement is rooted in the past, is cultivated to full stature by many contemporaries and flourishes only in a favorable environment. No individual is alone responsible for a single stepping stone along the path of progress, and where the path is smooth progress is most rapid. In my own work this has been particularly true. From the beginning of the Radiation Laboratory, I have had the rare good fortune of being in the center of a group of men of high ability, enthusiastic and completely devoted to scientific pursuits. I wish it were possible this evening for me to pay tribute individually to them all, for it was our joint endeavors that made possible the work which has been so magnificently recognized by the Nobel award; but I must content myself with accepting this great honor with the happy thought that I am the representative of these valued associates and friends.

I know also that I speak for my colleagues in the Radiation Laboratory as well as for myself when I take this felicitous opportunity to acknowledge with sincere gratitude the generous help we have received from many sources. The day when the scientist, no matter how devoted, may make significant progress alone and without material help is past. This fact is most self-evident in our work. Instead of an attic with a few test-tubes, bits of wire and odds and ends, the attack on the atomic nucleus has required the development and construction of great instruments on an engineering scale. This has been possible only through generous assistance from several quarters—notably the Research Corporation, the Chemical Foundation, the Rockefeller Foundation and from the late William H. Crocker, regent of the university. These benefactors share the honor of this occasion because without their help the work of our laboratory could not have been brought to its present fruition.

I have suggested that scientific progress requires a favorable environment. The University of California rightfully takes pride in the Nobel award because the university as a whole has contributed immeasurably in diverse ways to the work of the Radiation Laboratory. I shall always be grateful for the wise and generous guidance and help that our work has received from the University Board of Research, and especially from Professor Leuschner, chairman of the Research Board, in the early years of organization of the laboratory, and above all may I acknowledge my deep appreciation of the support of the president of the university, who whole-heartedly has been all along such a stimulus to our activities. It may truly be said that this Nobel award is yet another tribute to his great academic leadership.

It is a source of gratification to us all that we have been able to contribute a little to our understanding of the nucleus of the atom. We are glad that already in these early beginnings discoveries have emerged of immediate practical significance—for, as Professor Birge has so graciously said this evening, the new radiations and radioactive substances have opened vistas for all the sciences, especially in medicine. And in the Radiation Laboratory we count it a privilege to do everything we can to assist our medical colleagues in the application of these new tools to the problems of human suffering.

At the same time we have been looking towards the new frontier in the atom, the domain of energies above a hundred million volts, for we have every reason to believe that there lies ahead for exploration a territory with treasures transcending anything thus far unearthed. To penetrate this new frontier will require the building of a giant cyclotron, perhaps weighing more than 4,000 tons—twenty times larger than the new medical cyclotron of the Crocker Laboratory. We have been working on the designs of such a great instrument and are convinced that there are no insurmountable technical difficulties in the way of produc-

ing atomic projectiles of energies well above one hundred million volts, but of course such a great instrument would involve a large expenditure, and there is therefore a very considerable financial problem. Perhaps I might say that the difficulties in the way of crossing the next frontier in the atom are no longer in our laboratory; we have handed the problem over to the president!

Professor Birge has alluded to the very great importance of this project. As he has indicated, there are substantial prospects that it will be the instrumentality for finding the key to the almost limitless reservoir of energy in the heart of the atom. Certainly, it may bring to light such a deeper knowledge of the structure of matter as to constitute a veritable discontinuity in the progress of science.

Therefore, Mr. Consul-General, I believe that in this instance the award of the Nobel Prize is accomplishing to an unusual degree the purpose intended by Alfred Nobel—the encouragement of fundamental scientific research. For it goes without saying that such a great recognition at this time will aid tremendously our efforts to find the necessarily large funds for the next voyage of exploration farther into the depths of the atom, and let us cherish the hope that the day is not far distant when we will be in the midst of this new adventure.

In closing, may I again give expression to a profound feeling of gratitude and appreciation for this great honor, which I share with the university and with all those outside who have contributed to make our work possible and above all with my valued colleagues and co-workers, both past and present.

OBITUARY

FERDINAND ELLERMAN

FERDINAND ELLERMAN, a member of the staff of the Mount Wilson Observatory from its establishment in 1904, died of pneumonia on March 20, 1940, at the Queen of the Angels Hospital in Los Angeles, California. With a heart in a somewhat weakened condition, his strength was insufficient to rally from an attack of influenza which developed rapidly into the more serious disease. His wife, Hermine Hoenny Ellerman, and daughter, Louise Ellerman Burnett, survive him.

Ellerman was born at Centralia, Illinois, on May 13, 1869, and received a high-school education. For a few years he was in the employ of a commercial firm in Chicago, where he acquired marked skill in photography and in the use of machine tools. Dr. George E. Hale, himself but one year older than Ellerman, was at this time organizing his private observatory at Kenwood in Chicago and, needing an assistant, offered the position to Ellerman. This was in 1892, and the relationship begun at this time continued for nearly half a century until Hale's death in 1938.

Although without early training in astronomy, Ellerman rapidly gained a wide knowledge of its physical aspects and especially of solar spectroscopy. He was a remarkably skilful observer, and during the years at the Kenwood Observatory, 1892–1895, he contributed greatly to the notable work in solar physics in which Hale was engaged. Particularly in the development of the spectroheliograph, which Hale had designed, Ellerman's instrumental ability proved of the greatest value.

With the establishment of the Yerkes Observatory Ellerman went with Hale into the larger field of activity which the equipment provided. He aided in the design, construction and use of the Rumford spectroheliograph, which on the 40-inch telescope yielded some of the finest photographs of prominences and the upper solar atmosphere ever obtained. He also took part in solar and stellar spectroscopy, and his observations of N-type stars form an excellent illustration of a difficult investigation carried out with extraordinary patience and ability.

In 1904, when Dr. Hale decided to test observing conditions on Mount Wilson in California, Ellerman's observational skill and resourcefulness were called into play and were invaluable during the development of the observatory under the pioneering conditions of those early years. He took an active part in the investigations which led to the brilliant discoveries of solar vortices, the magnetic field of sunspots and the general field of the sun; and in later years to the discovery of the reversal of the sign of the magnetic field of spots with the sunspot cycle. He made many observations of sunspot spectra, and the Mount Wilson map of the sunspot spectrum was prepared by Ellerman almost wholly from his own negatives. His photographic skill, his inventive ability and his love of experimentation made numberless contributions to the successful operation of the observatory, and every one of his associates benefited extensively through his wide experience and friendly cooperation. The honorary degree of A.M. was conferred upon him in 1927 by Occidental College in recognition of his services to astrophysics.

Ellerman had many interests outside of his scientific work. He was fond of sports, of mountain climbing and of nature in all its aspects. Life on a mountain top was a constant delight to him. Although for nearly forty years he had suffered from the loss of

e sight of one eye, he overcame this handicap to ch a remarkable extent that it rarely appeared to ffect any of his activities.

In 1937 Ellerman retired from active duties at the bservatory, but he retained his interest in the work which he had devoted his life and was often a valued onsultant. His friendly presence will be greatly issed by his associates of many years.

WALTER S. ADAMS

MOUNT WILSON OBSERVATORY

RECENT DEATHS

DR. JAMES STACY STEVENS, until his retirement in 932 professor of physics and dean of the College of rts and Sciences of the University of Maine, with hich he had been associated since 1891, died on arch 24 at the age of seventy-five years.

GEORGE ANDREW LOVELAND, for ten years before is retirement in 1933 chief meteorologist of the Boston Weather Bureau, died on March 30. He was seventy-six years old and had been in the Weather Bureau for fifty-one years.

OWEN CATTELL, business manager and assistant to the editor of SCIENCE and the other journals of The Science Press, died of pneumonia on March 26 at the age of forty-two years. He was also director of the annual Exhibitions of the American Association for the Advancement of Science. Mr. Cattell was a fellow of the American Ethnological Society and had taken part in scientific expeditions in New Mexico and South America.

NOTICE has been received of the death on March 9 of Dr. Robert Theodore Gunther. Dr. Gunther was born in 1869, the eldest son of Dr. Albert Gunther, F.R.S., and was educated at University College School, London, and at Magdalen College, Oxford, of which he was for a long time fellow and tutor. He was also university reader in the history of science. He was an honorary doctor of laws of St. Andrews.

SCIENTIFIC EVENTS

THE MEDICAL SCHOOL OF THE UNIVERSITY OF QUEENSLAND

THE Medical School of the University of Queensland at Brisbane was officially opened on August 11 by the Honorable W. Forgan Smith, Premier of Queensland. This is the final achievement in the campaign for the provision of facilities for medical education in the state. According to *The British Medical Journal*, when in October, 1936, the Faculty of Medicine within the University of Queensland was inaugurated that function marked the successful issue of representations which began as long ago as the foundation of the university itself. The first proposals in 1913 were interrupted by the outbreak of war. In 1922 arrangements were made for anatomical demonstrations to be given to some of the dental students, who received two years' training at the dental school in George Street. In 1925, largely as the result of the work of a subcommittee of the Queensland Branch of the British Medical Association, a conference of delegates was called by the Home Secretary to discuss the subject. Two years later, with the cooperation of the Brisbane and South Coast Hospitals Board, a small school of anatomy for the teaching of dental students was established. In 1934 the activities of the anatomy school were transferred to a building given to the university for the purpose by the Freemasons of Queensland. In the following year a faculty of dentistry was established within the university and the Premier of Queensland appointed a select committee to report upon the practicability or otherwise of establishing a faculty of medicine and a faculty of veterinary science. The committee strongly advocated the institution of these faculties, and stated that the faculty of medicine should include particularly tropical medicine and public health as parts of routine medical education, and should be based upon recognition of the essential nature of the practical and clinical side of medicine. Meanwhile the College of Pharmacy was made available for the purpose of physiology. With the establishment of schools of anatomy and physiology it became possible to provide medical courses for students of the second and of the third year. The next step was to provide further accommodation to include the departments of pathology, social and tropical medicine, and other clinical departments. The Government undertook the cost and decided to provide buildings.

The new Medical School of the Queensland University occupies a commanding position at Herston on a site of over six acres adjoining the western boundary of the Children's Hospital and within a few minutes' walk of the Brisbane General Hospital. The building, in the Renaissance style, is three stories in height, and surmounted by a copper dome rising from a flat roof. If future extensions are required these can be added in the form of projecting wings at either end of the central block, which measures 222 feet in length. It is intended that fourth-, fifth- and sixth-year students shall receive in the school the whole of their training in all branches of medical and surgical science and that the third-year students shall receive their training in anatomy there, while first and second and the remainder of the third-year work will be carried out at the present university, and later on at the new building in course of erection at St. Lucia.

GIFTS AND BEQUESTS TO AMERICAN COLLEGES AND UNIVERSITIES

GIFTS and bequests to a selected list of 52 American colleges and universities fell off four per cent. in the fiscal year ending last June 30 as compared with the previous year, according to the annual study of educational finance made by The John Price Jones Corporation, fund-raising consultants. The total amount was $42,424,669 as compared with $44,235,986 reported for the year ending June 30, 1938—an average loss of $34,833 per institution.

This decline is less than the $4,742,548 drop recorded for 1937–38 and indicates a slowing up in the decline from the recent peak of $48,978,534 recorded for the year ending June 30, 1937.

The peak for the past 19 years covered by the report occurred in 1929–30 with gifts and bequests of $88,930,569; the low point came in 1933–34 with a total amount of $23,451,420. For the entire period the 52 institutions received a total of $909,243,982 in gifts and bequests.

The study showed that in the fiscal year 1938–39 gifts declined $3,914,662 while bequests gained $2,103,345. As in former years bequests again acted as a stabilizing influence. Of the four institutions which, in recent years, have received the largest gifts—Harvard, Yale, Chicago and Columbia—only Harvard failed to show a substantial gain in bequests, its bequests having dropped off nearly $1,000,000 from the previous year.

The drop in gifts was partly attributable to declines at the University of Chicago and Columbia University —$5,728,607 and $734,279, respectively.

Northwestern University with gifts and bequests of $7,462,178 for 1938–39 led all colleges and universities; Harvard was second with $4,424,830, and Yale third with $4,209,487. The University of Texas was fourth with $2,233,491 and Western Reserve fifth with $2,030,657.

For the first time since 1935–36 gifts to the nine women's colleges showed an increase—$12,842. Bequests to these colleges also increased by $251,402.

The report also compares giving to the selected institutions in times of prosperity and in times of depression. The annual average of gifts and bequests in the five years ending 1925–29 was $56,976,454, while the corresponding figure for the five years ending in 1935–39 was $41,848,403 or a drop of 27 per cent. Similar averages for the four wealthiest institutions (Harvard, Yale, Chicago and Columbia) are, respectively, $26,404,456 and $18,233,407 or a drop of 31 per cent. Thus the wealthier universities suffered proportionately more than did the other institutions in times of depression.

THE CATSKILL MEETING OF THE NEW YORK STATE GEOLOGICAL ASSOCIATION

AN attendance of three hundred is expected at the sixteenth annual meeting of the New York State Geological Association, to be held this year in Catskill, New York, on Friday and Saturday, April 26 and 27. The two days will be given to field trips in this region, which is of unusual geological richness. There will be a dinner, talks on local geology and a social gathering on Friday evening.

The Catskill region includes strata of Lower Cambrian, Lower Ordovician and Upper Silurian to Upper Devonian ages, separated by a great unconformity (Taconic revolution), and varying from flat-lying in the Catskill Mountains through the well-known "miniature Appalachian" folds at their foot to isoclinally compressed and partly metamorphosed east of the Hudson. The lower portion of the succession is marine and mostly highly fossiliferous; the upper part is the continental "redbeds" series of the great Catskill delta (Old Red Sandstone), with the Gilboa forest trees, rarely fishes and freshwater clams.

Three peneplains, noted stream piracy, glaciation and the post-glacial Lake Albany clays and deltas with a variety of physiographic types, and in addition the cement, flagstone, brick industries and old iron mines, all are enhanced by the beauty of the scenery.

The officers are George Halcott Chadwick, *president*, and Robert Weeks Jones, *secretary-treasurer*. The headquarters and mail address will be the modern Catskill Junior-Senior High School Building, which has been opened to the association through the courtesy of the Board of Education and Dr. Maurice S. Hammond, superintendent of the Catskill schools. The citizens of Catskill are sponsoring the meeting through the Catskill Chamber of Commerce, the Board of Trustees, the Rotary Club and the Firemen's Association.

THE LEDYARD FELLOWSHIP AWARDS OF THE NEW YORK HOSPITAL

THE first awards under the Lewis Cass Ledyard, Jr. fellowship, "for original medical research of high order," have been made to Dr. Willis Fiske Evans, of Richmond, Va., and Dr. Charles O. Warren, Jr., of Boston, according to an announcement made by Henry S. Sturgis, treasurer of the New York Hospital.

The fellowship was established last year by Mrs. Ruth E. Ledyard in memory of her husband, a governor of the hospital. Inasmuch as no appointment was made at that time, the present awards are for both 1939 and 1940.

Dr. Evans, whose fellowship provides for a study of the peripheral blood flow, attended Randolph-Macon College and the Medical College of Virginia. He was

instructor in pathology at the Medical School of e University of Virginia, and currently is conducting search in cardiology at the Cornell University Medl College.

Dr. Warren, who will continue research under the ard in the physiology of the bone marrow, attended rnell University and the Medical College, and reived a doctorate of philosophy from New York Unirsity. He is now an instructor in physiology at the rnell University Medical College, and is the recipient a grant in aid of research from the Committee on ientific Research of the American Medical Assotion.

Under the terms of the annual award, approximately ,000 will be provided for the research of each fellow, osen from applicants from all parts of the country. e fund was established to aid research "in the fields medicine and surgery, or any closely related field."

HE TWELFTH ANNUAL SCIENCE FAIR OF THE AMERICAN INSTITUTE

MORE than 375 exhibits, built entirely by students d bearing on many aspects of science, will be prented at the twelfth annual Science and Engineering air under the auspices of The American Institute ience and Engineering Clubs to be held at the Hall Education of the American Museum of Natural istory, New York City. The exhibit will open on nday, April 14, at 1 P.M. and will continue through pril 20.

The American Institute Science and Engineering ubs is an association of many hundreds of science ubs formed in junior and senior high schools, nior chambers of commerce, junior academies of ience, settlement houses, Boy and Girl Scouts and dependent scientific bodies. Annually an exhibin is held at which the public may view projects mpleted during the past year. These are judged by mmittees comprised of well-known scientific men, ucators and laymen. Prizes amounting in all to ,000 will be awarded with the stipulation that the onetary awards must be spent in the furtherance of ientific work.

Everything from the "Life of Prehistoric Man" to hemistry for Beauty," from "Movements of the arth" to "Weather Forecasting" and from "Heat" "Atom Smashing" will be on display. Many of ese exhibits are working models which the spectors may operate by pressing a button. Experients with animals and plants are well represented. me of the exhibits come from as far west as Colodo. They are about equally divided between indidual and group projects.

Many local fairs are held during the year at the ience Centers of the American Institute throughout e country, and the best of these exhibits are selected for display at this national fair. Prize-winning exhibits will be displayed at The American Institute Students' Science Laboratory at the World's Fair.

MEETINGS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

THE spring meeting of the American Society of Mechanical Engineers will be held at the Hotel Bancroft, Worcester, Mass., from May 1 to 3. The Honorable William A. Bennett, mayor of Worcester, and Admiral Wat Tyler Cluverius, president of the Worcester Polytechnic Institute, will greet the visitors officially at a general luncheon to be held at the hotel. President Warren H. McBryde will respond on behalf of the society and its 15,000 members.

The guest speaker at the luncheon will be Dr. John F. Tinsley, president of Associated Industries of Massachusetts and president and general manager of Crompton and Knowles Loom Works. At the formal banquet on Thursday evening a speech entitled "The Progress Report of an Amateur Economist" will be given by Ralph E. Flanders, president of Jones and Lamson Machine Company and a past president of the society.

Visiting engineers and executives will be given an opportunity to inspect the work of mechanical engineers in and about Worcester by means of visits to the principal plants. Fourteen simultaneous technical sessions are included in the program. Twenty-seven papers will cover the subjects of management, steam power, process industries, machine-shop practice, fuels, boiler feedwater, hydraulics, iron and steel, heat transfer and materials handling.

The semi-annual meeting of the society will be held in Milwaukee from June 17 to 20, with headquarters at the Hotel Pfister. Supplementing the engineering papers there will be inspection trips to manufacturing plants in the vicinity of Milwaukee. The city is particularly noted for the development of heavy machinery.

It is planned to have one or more sessions on each of the following subjects: fuels, heat transfer, flow of water, hydraulic equipment, machine-shop practice, management, steam turbines, power plants and steam power. There will also be a symposium on steam-locomotive valves and valve mechanism. The chairman of the Aeronautic Division, Charles H. Dolan, has arranged for technical papers on turbulence and energy dissipation, the hard-facing of metal surfaces, tool and die milling, power-plant heat insulation and experience with metals at high temperatures.

The General Committee is making arrangements to provide visitors with facilities for golf, tennis, swimming, sailing and other recreational activities. There will be luncheons, dinners and a formal banquet.

SCIENTIFIC NOTES AND NEWS

A DINNER was given on April 4 in honor of Dr. Edward Kremers, professor of pharmaceutical chemistry at the University of Wisconsin from 1892 until his retirement with the title emeritus in 1935. The dinner was under the sponsorship of the Wisconsin Pharmaceutical Association, the State Board of Pharmacy and the University School of Pharmacy. Dr. Kremers was presented with an engraved plaque honoring his fifty years' work in pharmacy in the university. The main address was given by Dean Charles Rogers, dean of the School of Pharmacy of the University of Minnesota and president of the American Association of Colleges of Pharmacy.

DR. E. D. MERRILL, director of the Arnold Arboretum of Harvard University, in appreciation of his services to the institution in the general field of botany, has been elected an associate in the Museum of Natural History, Paris.

DR. FREDERICK C. LEONARD, associate professor of astronomy at the University of California at Los Angeles, has been elected to life membership in the Royal Astronomical Society of Canada.

DR. LILLIAN M. GILBRETH, president of Gilbreth, Inc., and professor of management at Purdue University, was made an honorary life member of the Engineering Woman's Club at a dinner given in her honor on March 22. The citation reads: "For your scientific achievements in the field of industrial psychology, for your pioneer work in applying these principles to the practical problems of the efficiency of human labor; for your intelligent womanhood and for the esteem in which you are held by your fellow members."

AT the meeting of the Society of Experimental Psychologists held on March 26 and 27 at the University of Pennsylvania, the Howard Crosby Warren Medal was awarded to Ernest R. Hilgard, of Stanford University, for his analysis of the conditioned response and his demonstration of its integration with the verbal and volitional processes in learning and retention. The Warren Medal is awarded annually by the society "for outstanding research in the field of experimental psychology."

Nature states that the council of the Royal Society of Edinburgh has awarded the Keith Prize for the period 1937–39 to Professor F. A. E. Crew for his papers and joint papers in the *Proceedings* of the society within the period of the award, and in recognition of his contributions to animal genetics; and the Neill Prize to Mr. James Wright, for his paper on "The Scottish Carboniferous Crinoidea," published in the *Transactions* of the society.

DUE to the scientific importance of the two expeditions for deep-sea fishing around Cuban waters carried out on board the research vessel *Atlantis* of the Woods Hole Oceanographic Institution, under the auspices of Harvard University, and the University of Havana, the Cuban Geographical Society (Sociedad Geográfica de Cuba) has awarded gold medals to Dr. William C. Schroeder and Dr. Luis Howell Rivero; and silver medals to Dr. Carlos G. Aguayo and Dr. Pedro J. Bermudez, all members of the expedition. Dr. William C. Schroeder, curator of fishes of the Museum of Comparative Zoology, represented Harvard University and acted as director; Dr. Luis Howell Rivero, professor of anthropology and curator of fishes at the University of Havana, obtained the official cooperation of the Cuban Government. Dr. Carlos G. Aguayo, professor of zoology and acting director of the Museo Poey, of the University of Havana, and Dr. Pedro J. Bermudez, professor of zoology of the University of Havana, cooperated in both trips.

IN a recent issue of SCIENCE it was stated that the Mead Johnson and Company prize of $1,000 had been awarded jointly by the American Institution of Nutrition for the work on riboflavin by Dr. W. H. Sebrell and to investigators in the research laboratories of Merck and Company for the synthesis of pantothenic acid. The latter is incorrect; the award was made for the synthesis of Vitamin B_6. The recipients were Drs. John C. Keresztesy, Joseph R. Stevens, Stanton A. Harris, Eric T. Stiller and Karl Folkers.

AT the annual meeting of the American Association of Pathologists and Bacteriologists held in Pittsburgh on March 20 the following officers were elected: Dr. S. Bayne-Jones, *president;* Dr. S. R. Haythorn, *vice-president;* Dr. Howard T. Karsner, *secretary;* Dr. Alan R. Moritz, *treasurer;* Dr. Malcolm H. Soule, *incoming member of the council;* Dr. Carl V. Weller, *editor-in-chief of the American Journal of Pathology;* Dr. Tracy B. Mallory, *assistant editor of American Journal of Pathology;* Dr. Granville A. Bennett, *assistant treasurer,* Dr. Francis Bayless, *assistant secretary.*

AT the seventh annual meeting of the American Institute of Nutrition held in New Orleans on March 13, the following officers were elected: *President,* T. M. Carpenter; *Vice-president,* A. G. Hogan; *Treasurer,* W. H. Sebrell; *Secretary,* L. A. Maynard; *Councilor,* Lydia J. Roberts; *Associate Editors,* Lela E. Booher, H. B. Lewis, A. T. Shohl and E. B. Forbes.

DR. HARRY STOLL MUSTARD, professor of preventive medicine at the New York University College of Medicine, has been appointed professor of public

health practise and director of the DeLamar Institute of Public Health of Columbia University. He is a member of the Board of Scientific Directors of the International Health Division of the Rockefeller Foundation and of the public health committee of the Commonwealth Fund. He will succeed Dr. Haven Emerson, who will retire on July 1. Dr. Ernest L. Stebbins, assistant commissioner for preventable diseases in the New York State Department of Health, has been named professor of epidemiology, and Dr. John W. Fertig, associate in biostatistics in the School of Hygiene and Public Health of the Johns Hopkins University, has been appointed professor of biostatistics.

Dr. George Glockler, professor of physical chemistry at the University of Minnesota and a member of the staff of the School of Chemistry since 1926, has been elected head of the department of chemistry of the State University of Iowa.

Dr. James E. Knott, research professor of vegetable crops at Cornell University, has been appointed head of the Division of Truck Crops at the College of Agriculture of the University of California at Berkeley, the appointment to become effective on July 1.

Henry V. Hubbard, Charles Dyer Norton professor of regional planning at Harvard University, will retire in the autumn. It is reported that technical training in regional planning will be discontinued "because sufficient funds for adequate instruction are not available." It is, however, stated that the committee in charge will investigate ways of continuing instruction and research in regional planning.

Dr. Paul H. Fall, since 1936 associate professor of chemistry at Williams College, has been appointed president of Hiram College, Ohio, where he was chairman of the department of chemistry from 1920 to 1936. He will take up the work of the presidency in September.

The British Medical Journal reports that Dr. Denis J. Coffey, having reached the age of retirement fixed by statute, is to relinquish the presidency of University College, Dublin. It is now a little over thirty years since Dr. Coffey, then a physiologist of distinction and of growing reputation in his own field, was appointed the first president of the new college.

Dr. Dexter M. Keezer, since 1934 president of Reed College at Portland, Ore., has been appointed a member of the Science Committee of the National Resources Planning Board. Members of the committee, of which Dr. E. B. Wilson, of Harvard University, is chairman, are nominated by the Social Science Research Council, the National Academy of Sciences, the American Council on Education and the American Council of Learned Societies. Dr. Keezer was nominated by the Social Science Research Council. The committee is now undertaking studies for the purpose of making a comprehensive review of the research resources of the United States, including those of industrial laboratories, business organizations and state and local governments.

A cable to *The New York Times* from Lima, Peru, states that a Swedish scientific expedition financed by Axel L. Wenner-Gren, the Swedish industrialist, planned to leave Lima by automobile for Arequipa on March 29 and to proceed by railroad to Cuzco and thence by plane to Puerto Maldònaldo in the Department of Madre de Dios. The expedition is cooperating with the Viking Foundation for Scientific Research and with the Museum of the American Indian, Heye Foundation, New York. Dr. Paul Fejos, of Hungary, is at the head of the party. Its other members include Dr. Kenneth Lowther, geologist, of Toronto; Count Jarl Cronstadt; Herman Besserman, radio operator, and Earl Rossman, photographer. The expedition will collect ethnological, zoological and geological data.

Richard C. Potter, of Concord, N. H., has been appointed director of the Worcester Natural History Society, Massachusetts, to succeed Harry C. Parker.

Recent visitors to the School of Tropical Medicine at San Juan, Puerto Rico, were Dr. Ernest E. Irons, formerly dean of Rush Medical College, Chicago, and Dr. Magnus I. Gregersen, head of the department of physiology of the College of Physicians and Surgeons, Columbia University. Dr. Willard C. Rappleye, dean of the College of Physicians and Surgeons, also paid a short visit as the guest of the School of Tropical Medicine.

Dr. Rollin Thomas Chamberlin, professor of geology at the University of Chicago, will give the fourth series of Grant Memorial Lectures at Northwestern University on April 15, 17 and 19. There will be one non-technical lecture on "Earthquakes" on the evening of April 17 and four technical lectures on the following subjects: "The Structure of the Middle Rocky Mountains"; "An Outline of the General Tectonic Features"; "Summary of Tectonics and the Inferred Nature of the Major Processes"; "Nature of Processes, Gravity Studies and Comparisons."

The first Charles Edward Munroe Memorial Lecture, which was established at George Washington University by the Alpha Pi Chapter of Alpha Chi Sigma Fraternity, was given on April 3 by Ernst A. Hauser, associate professor of chemical engineering at the Massachusetts Institute of Technology, who spoke on "Recent Advances in the Colloid Chemistry of Clay Minerals."

Dr. Edmund W. Sinnott, of Barnard College, Columbia University, whose appointment as Sterling

professor of botany at Yale University was recently announced, made an address entitled "Science and our Modern Dilemma" on March 30, before the annual banquet of the Yale chapter of Sigma Xi. Dr. Sinnott will join the faculty of Yale University in the autumn at the opening of the college year.

DR. HERBERT M. EVANS, professor of biology and director of the Institute of Experimental Biology of the University of California, gave two lectures on April 1 under the auspices of the Research Council of the Graduate College on "The Relation of Vitamin E to the Neuromuscular System" and "The Historical Evolution of our Knowledge of the Anterior Pituitary."

DR. JOHN F. FULTON, Sterling professor of physiology at Yale University, was one of the lecturers last month in the annual national Sigma Xi series on "Science in Progress." He lectured on "Experimental Studies on the Functions of the Frontal Lobes in Monkeys, Chimpanzees and Man" at the University of Vermont, the University of Kansas, Stanford University, the University of Washington, the State College of Washington, the Mayo Foundation, Beloit College, the University of Illinois, the University of Illinois College of Medicine, Northwestern University and Swarthmore College.

DR. PETER DEBYE, director of the Physical Institute of the Kaiser Wilhelm Institute, Berlin, on April 1 addressed the North Jersey Section of the American Chemical Society. He spoke on "Molecular Structure Determined by Interference Methods." Dr. Debye is the George F. Baker lecturer at Cornell University during the present semester.

A DECISION was handed down on March 30 by Supreme Court Justice John E. McGeehan revoking the appointment of Bertrand Russell as professor of philosophy at the College of the City of New York. Justice McGeehan sustained the contention of a taxpayer that Professor Russell was not fit for the position because of his attitude toward sex, and was not legally qualified because he is not a citizen of this country. Earl Russell was appointed originally by a unanimous vote of the Board of Higher Education. After the appointment had been attacked by Bishop William T. Manning and others the board refused on March 19 by a vote of 11 to 7 to reconsider the appointment, which is for the term beginning February, 1941, and ending June, 1942. Earl Russell is now lecturing at the University of California at Los Angeles, and will lecture at Harvard University in the autumn.

THE office of the Royal Society was moved from Cambridge to the society's headquarters in Burlington House, London, on March 18. The library is to be reopened.

DISCUSSION

LABORATORY CHIMPANZEES[1]

QUARTERS have recently been completed at Yale Laboratories of Primate Biology, Orange Park, Florida, for an experimental nursery. Infants separated from their mothers at birth are to be reared under controlled conditions and used as subjects of a special program of research, of which Dr. Henry W. Nissen, assistant director, will be in charge. The Samuel S. Fels Fund has agreed to associate itself with the Laboratories in the support of this undertaking. Initially attention will be concentrated on the comparative study of problems of behavioral development and adjustment, growth and maturation. To date (March, 1940) 34 infants have been born in the laboratory colony, which now contains 27 individuals of known birth-date and recorded life history. The ape population on March 10, 1940, numbered 47,[2] with an age range from 4 days to 27 years. Several of these chimpanzees have been in use in the Laboratories for from 8 to 14 years. The normal life span of this great ape when in captivity has not been determined, but it is indicated that the reproductive life may exceed 30 years, and it would seem probable that under favorable nutritional, hygienic and social conditions the individual may live for 50 years.

The Laboratories can now announce a second generation (the third generation in captivity). Alpha, the first infant born in the colony,[3] gave birth on October 17, 1939, to a son, who has been named Alf. The maternal grandparents, Pan (1922)[4] and Dwina (1920),[4] were brought to the Laboratories from Africa by animal dealers in 1925. The paternal grandparents are unknown. Alf's parents are Frank (1930),[4] purchased by the Laboratories in 1933, and Alpha, born on September 11, 1930.

In this ancestral history the estimated interval between the first generation (Pan-Dwina) and the second generation is 9–10 years; that between the second (Frank-Alpha) and the third is almost exactly 9 years. Whatever the average interval in nature, it appears that in this breeding colony it is not less than 9 years.

[1] Acknowledgment is made by the author, for contributions to the observational records upon which this report is based, to Drs. H. W. Nissen, J. H. Elder and G. Finch.

[2] Of this number, 7 immature individuals were in the Northern Division of the Laboratories, New Haven.

[3] C. F. Jacobsen, M. M. Jacobsen and J. G. Yoshioka, *Comp. Psychol. Monogr.*, Vol. 9, no. 1, 1932.

[4] Hypothetical birth-date.

Alpha's weight at birth (2.26 kg) is the greatest thus far recorded in the colony. Her son's birth weight (2.14 kg) is the next in order. In motor development, Alf is approximating closely his mother's exceptionally rapid growth. Precocity is suggested also by Alpha's sexual development, since she first menstruated at 7 years, 11 months, and became pregnant at 8 years, 5 months. The infant Alf was delivered after a gestational period of approximately 235 days.

Neither Dwina[5] nor her daughter Alpha accepted and cared for her first-born infant. Instead, each of these primiparous mothers behaved as if surprised, bewildered and lacking suitable ready-to-hand patterns of behavior for the novel emergency. Neither consumed the afterbirth. By contrast, the multiparous or experienced chimpanzee mother usually eats at least a portion of the afterbirth, and she almost invariably treats the newborn infant as a familiar object, handling it freely, skillfully, and by proper treatment assuring its welfare. Only very exceptionally does she entirely ignore or refuse to take care of her baby.[6] The structurally determined maternal behavior of the primiparous chimpanzee is importantly supplemented by acquisitions resulting from individual reproductive experience and also by social tradition.

Baby Alf is an especially prized recruit to the experimental nursery group because the offspring of an extraordinarily gentle, intelligent and cooperative male and a docile female who, bred and reared in the Laboratories, throughout her life has been accustomed to handling and use as a subject of psychobiological experiments. In this mating a first step has been taken toward breeding the chimpanzee to specification as laboratory animal. Should the temperament of Alf resemble closely that of father, mother, or both, he will be peculiarly valuable as sire and as subject for experimental studies.

Robert M. Yerkes
Yale Laboratories of Primate Biology

THE RELATIONS OF SOILS AND SURFACE IN THE SOUTH CAROLINA PIEDMONT

Systematic studies of the physiographic factors of soil erosion in the South Carolina Piedmont, carried on for the past three years by the Climatic and Physiographic Division of the Soil Conservation Service, have led to a considerable revision of current ideas concerning the development of soils and have cast new light on the recent geomorphic history of the region.[1]

[5] O. L. Tinklepaugh, *Anat. Rec.*, 53: 193, 1932.

[6] R. M. Yerkes, Science, 81: 542, 1935.

[1] A publication by H. A. Ireland, C. F. S. Sharpe and D. H. Eargle, "Principles of Gully Erosion in the Piedmont of South Carolina," U. S. Dept. Agr. Tech. Bul. No. 633, 143 pp., illus., January, 1939, summarized the processes of gully formation, considered the interrelation of causal factors and described the successive stages in gully development.

Exposed by gullies which have recently developed in the valley heads, dales and other natural drainageways, are deposits of organic material as much as twelve feet in thickness and buried under twenty feet or more of soil. Most of the deposits are rich in pollen and contain quantities of stem fragments, trunks, stumps and roots of trees as well as sedges and other herbaceous plants, usually well-preserved but compressed by the weight of the overlying deposits, although in some sites the material consists almost entirely of charcoal fragments.

A preliminary analysis of the pollen in some of the deposits by Dr. Stanley A. Cain, of the University of Tennessee, showed an abundance of fir and spruce, which indicates that the climate at the time the deposits were formed was considerably colder than the present-day climate. Further microbotanical study of the organic material is expected to show the relative abundance of the various plant species represented, their succession in the deposits, and hence, possibly, the age of the deposits and climatic conditions at the time they accumulated.

Most of the deposits examined are in Spartanburg County, South Carolina. A much wider distribution is indicated, however, by reports of similar deposits elsewhere in the Piedmont and in other physiographic provinces from Maryland to Alabama.

That the material which overlies the organic deposits has migrated down slope en masse as soil creep, earthflow and slumping, and perhaps to some extent as sheet wash, can not be questioned. Within the soil material itself are unmistakable evidences of migration. In many places the underlying saprolite with the original rock structure still well preserved is sharply truncated at the soil contact. In places, the soil contains unassorted masses of clay and sand mixed with boulders that can be traced up-slope to existing veins and dikes of resistant and only partially weathered rock, and near the base of the soil "stone lines" often occur. Horizontal laminations in partially assorted materials and lenses of sands and gravels in the lower soil horizons indicate soil movement in association with running water.

To supplement observations made in gully walls and to determine the areal distribution of the transported soil, more than 800 holes were bored at regular intervals through the entire soil profile from the surface to the underlying decayed rock. In one area studied in detail, typical of much of the South Carolina Piedmont, about 50 per cent. of the surface is underlain by soil materials definitely proved to have been transported.

Hitherto, most Piedmont soils were thought to have developed from material of residual origin. The discovery of organic material underlying many of the soils, including Cecil, Appling, Colfax and Worsham,

and the existence within the soils themselves of the evidence of migration in such widely differing soils as Durham, Iredell, Georgeville, Lockhart, Davidson and Wilkes demonstrate that these soils are not everywhere residual, and suggest that some of the distinguishing characteristics of the individual soil types may be due to migration. Similarly, variations within individual soil types may be attributed to the partial assortment of materials during soil migration.

Furthermore, the tremendous thickening of the soil mantle above the organic matter on the concave slopes indicates that local relief has been diminished and surface landforms softened. The upland surface has been reduced in elevation, the valleys have been aggraded and the connecting slopes have been reduced in grade.

In the Piedmont, at least, lateral migration of soils and soil materials ranks with vertical movement of material within the soil profile as an agent of soil genesis and as a factor in determining soil characteristics and the distribution of soil types. The physiographic processes of mass-movement which are important in soil formation are also responsible for the minor landforms of the region. Thus, it would seem desirable to emphasize physiography and landforms in the mapping and interpretation of soil types; and conversely, to consider the influence of soil in the development of surface configuration.

D. HOYE EARGLE

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WASHINGTON, D. C.

BORON DEFICIENCIES IN CONNECTICUT

IN the July 14, 1939, number of SCIENCE, W. L. Powers, of Oregon, reported striking results in the control of alfalfa "yellows" by an application of 30 pounds per acre of boric acid. Yields during dry weather were trebled and the quality of the hay greatly improved by the use of boron. Beneficial effects were noted also on other crops.

For several years, the Storrs (Connecticut) Agricultural Experiment Station has been exploring the possible needs of field crops for minor elements, including boron. No responses were obtained until, during the dry summer of 1939, the top leaves of alfalfa yellowed and buds failed to develop into blossoms on all the experimental plots that had not received borax. This was true of a variety of treatments, including stable manure. Where borax at 20 pounds per acre (2.3 pounds or 1.15 p.p.m. of boron) had been added the previous August, these symptoms of boron deficiency were almost entirely absent. The second cutting yields were increased 16 per cent. by the borax, and chemical analyses of the alfalfa gave the following data: Boron in dry matter (p.p.m.): with borax, leaves 62, stems 22; without borax, leaves 21, stems 16.

These results occurred on one of the best agricultural soils in Connecticut. Alfalfa "yellows" was also observed on several farms in August, 1939. Reports indicate a wide-spread occurrence of "internal cork" of apples (a symptom of boron deficiency) in Connecticut the past season. Thus, it appears likely that under certain soil and weather conditions, other crops might be benefited by additions of boron.

B. A. BROWN

STORRS (CONN.) AGRICULTURAL
EXPERIMENT STATION

RECEIPT OF EUROPEAN JOURNALS DURING THE WAR

SHORTLY after the war began in Europe the American Documentation Institute, with the approval of the Division of Cultural Relations of the Department of State, circulated notices, which were published in various scientific and scholarly journals, stating that it would attempt to secure information about whether or not scientific journals were being delayed in delivery in this country due to war conditions. A considerable number of communications have been received and handled in response to these notices. In almost all cases it is evident that non-receipt of journals by libraries and other subscribers is due to action on the part of agents in Germany holding journals for transmittal when, in their opinion, shipment to this country will be safer. On the other hand, journals that have been ordered direct from and sent directly by the publishers have in practically all cases been arriving safely and relatively on time.

The non-receipt of journals that are held by agents does present a serious problem. This situation is well expressed in a letter from an ADI member, Dr. E. J. Crane, editor of *Chemical Abstracts,* Columbus, Ohio (Feb. 27, 1940):

> As you no doubt know, some libraries and individuals are getting German and other European periodicals regularly now, or almost regularly, whereas others are not getting any copies. The difference seems to be that those who are getting copies deal directly with the publishers or obtain their copies through agents who are attempting to make deliveries. Those who are not getting their copies deal with agents who are accumulating copies overseas with the idea of holding these until deliveries may be made more safely, which probably means until the war is over. We deal directly with German and other publishers and we are getting our journals regularly for the most part. We do not obtain all of the journals which are abstracted, however, and many of our abstractors are dependent on libraries whose periodicals are not being delivered.
>
> No doubt our problem is merely one of many encountered by scientists under these conditions. The lack of complete files of current journals is a serious handicap to research in this country, I believe.
>
> I wonder if anything can be done to persuade librarians

to attempt having deliveries made now if their copies are being impounded at the source. It may be that they are trying and on the other hand I think it possible that some of them consider it more important to insure complete files for the future than to run risks in delivery now. It is this particular point which has prompted this letter to you. One of the very new efforts of the American Documentation Institute has been to copy whole journals either on microfilm or by photoprinting. If some way could be found to reassure librarians that occasional missing numbers for the war period which they could not obtain from the publishers after the war could be replaced by photoprinting at reasonable costs, this might influence their present practice in the direction of taking care of present needs of scientists and others.

The situation with regard to German journals as to editions published is given in the following letter from G. E. Stechert and Company, New York City (March 6, 1940):

German publishers usually print a considerable number of copies in excess of their actual need for subscribers but this has changed during the last two years. We have only recently been advised that due to some paper shortage only copies for the exact number of subscribers will be printed.

At the annual meeting of ADI, the suggestion was made that activities of ADI in the field being discussed should be coordinated with those of the Librarian of Congress and the American Library Association. Contact has been made with Archibald MacLeish, Librarian of Congress, and any necessary communications with regard to the general policy of handling of journals from abroad will be channeled through him. It is understood that negotiations are underway whereby arrangements for clearance of scholarly and scientific journals from Germany may be made. However, the fact that such journals are coming through with regularity when shipped by the publishers seems to take care of the immediate situation, except in those cases where agents are holding copies for future delivery.

From the information gathered, the following recommendation can be made:

That libraries and individuals who have ordered through agents and who are not receiving journals from abroad should instruct those agents to dispatch currently the journals in order that they may be received promptly and be available for readers when they are current. In the event that losses are incurred through this procedure, it would be possible for libraries and individuals to obtain missing numbers through microfilm or photographic enlargement, which makes unnecessary the precaution of holding journals at source until the end of the war or some other future time.

WATSON DAVIS
AMERICAN DOCUMENTATION INSTITUTE,
WASHINGTON, D. C.

SCIENTIFIC BOOKS

SEDIMENTATION

Principles of Sedimentation. By W. H. TWENHOFEL. 511 pp. 44 figs. New York: McGraw-Hill Book Company. 1939. $5.00.

GRABAU, Barrell and Twenhofel will long be remembered as leaders in the twentieth century revival of interest in the origin and history of sedimentary rocks. Twenhofel's books have been immeasurably valuable in summarizing the constantly increasing volume of information; they are indispensable aids to every student of the subject. The latest, the "Principles of Sedimentation," traces the history of the sedimentary rocks from the places of origin of their components to their deposition and consolidation.

The first three chapters, on environments, present the physical and climatic background without which the history of sedimentation can not be properly understood. Chapters IV to VI give an excellent treatment of the origin and transportation of the inorganic sediments and the relationships of organisms to them. Chapter VII, on the classification of sediments, sedimentary rocks and minerals, is far too brief. Chapter VIII treats of the accumulated clastic sediments, both newly deposited and indurated. It seems unfortunate that limestone was not included here, for most marine limestones are just as much clastic sediments as are sandstones. Chapters IX to XIII, with the general heading "Sediments of Chemical Deposition," discuss the origin of limestone, dolomite, evaporites, sedimentary iron ores, a host of lesser chemically-formed mineral deposits and, curiously, the carbonaceous sediments. Much of the material in some of these chapters is of little importance to the stratigrapher. Chapter XIV, on structural features of sedimentary origin, is most useful. The final chapter, on textures and colors of sediments, is mostly repetition of what has been said earlier in the book.

The story is a highly complex one, and some parts of it are so obscure that about all that can be done is to set forth the lines of research that should be followed to furnish information. On the whole, Twenhofel has done a good job. The chief criticism of the book is merely that there is too much of it. Another edition of the "Principles" might well begin with Chapter IV. The first three chapters are covered by any good introductory course in geology, and much that they contain is repeated in later parts of the present volume. Chapters IV to VI could be followed

by chapters VIII and IX, the clastic and carbonate sediments, and the book concluded with chapter XIV, the structural features of sedimentary rocks. These portions of the book describe the rocks most commonly encountered and illustrate all the general principles. An edition containing the material mentioned above (278 pages), and selling for two thirds of the present price, would be a boon to college students.

The book is to be commended for the impartiality with which the various facts and theories are presented. The bibliographies are excellent, up to date and well placed. There are, of course, some statements with which not all will agree and a few minor errors. There are remarkably few typographical mistakes. One of them might well be repeated in future editions, for when the compositor makes the author say that in many dolomites the fossils are "silified," many who have studied these rocks will think he has achieved the *mot juste*.

PERCY E. RAYMOND

HARVARD UNIVERSITY

SUBMARINE CANYONS

The Origin of Submarine Canyons. By DOUGLAS JOHNSON. 126 pp. 4 figs. 4 plates. New York: Columbia University Press. 1939. $2.50.

ONE of the most puzzling features on the face of the earth is the series of spectacular submarine canyons which notch the margins of the continental platforms and extend downward and outward to depths of eight or ten thousand feet below the surface of the sea. Their origin is perhaps the most baffling problem faced by geologists at the present moment, and their presence has caught the interest of the general public to an unusual extent. This slender volume from the pen of Columbia University's well-known geomorphologist should therefore be called to the attention of a larger audience than the small group of specialists working on the problem.

Professor Johnson reviews critically the numerous hypotheses that have been under consideration and rejects the idea that the canyons are a result of subaerial erosion at a time when the continents stood higher with respect to sea level than they do to-day. He also concludes that erosion by turbidity currents has "such doubtful validity that one is impelled to seek elsewhere a more satisfactory explanation of the great trenches found beneath the sea." He therefore attempts to explain the canyons "as the result of long-continued sapping by submarine springs fed . . . by waters, chiefly artesian, migrating through the sediments of the continental shelf to appear on its steeper seaward face." Although that explanation may appear incredible at first glance, Professor Johnson's marshaling of data and cogency of logic are such as to give much plausibility to his ideas.

KIRTLEY F. MATHER

HARVARD UNIVERSITY

A NEW GERMAN SCIENCE DICTIONARY

German-English Science Dictionary for Students in the Agricultural, Biological and Physical Sciences. By LOUIS DE VRIES, professor of modern languages, Iowa State College, and collaborators. Pp. x+473. New York and London: The McGraw-Hill Book Company, Inc. 1939. $3.00.

ATTENTION should be called to this much-needed valuable little dictionary for aid in reading scientific German, especially when one must traverse other fields outside one's own. It measures only *ca.* $7\frac{1}{4}'' \times 5\frac{1}{4}'' \times 1''$, but contains 48,000 entries; the book has been kept "pocket-size" by omitting many compound words whose meaning can readily be derived from the components. There has been a crying need for just such a volume to serve general science in the manner that Patterson's serves chemistry. Included among the collaborators are men and women in the fields of botany, bacteriology, genetics, entomology, zoology, psychology, biochemistry, nutrition, etc., etc.; by this means, the vocabulary selection and word-meanings have been broadly selected and will serve a large group of people.

HAROLD KENNETH FINK

CALIFORNIA INSTITUTE OF TECHNOLOGY

SOCIETIES AND MEETINGS

PENNSYLVANIA ACADEMY OF SCIENCE

THE regular spring meeting of the Pennsylvania Academy of Science was held at Washington and Jefferson College, Washington, Pennsylvania, on Friday and Saturday, March 22–23, 1940. Ninety-six persons registered. A general session occupied the members on Friday morning. In the afternoon Geologic and Biologic sections met separately. Saturday was given over to another general session. A total of forty-four papers appeared on the program. The annual dinner was held on Friday evening at the George Washington Hotel. After the dinner, Dr. E. T. Wherry, of the University of Pennsylvania, gave a public address on "Notable Native Plants of Pennsylvania." This was illustrated with colored slides.

Simultaneously with the Senior Academy, 258 members of the Junior Academy met under the guidance of Professor K. F. Oerlein. The next regular spring session of the Academy is scheduled for April 11-12, 1941, at Coatesville, Pennsylvania, under the auspices of the Chester County Natural History Society. The place and date of the 1940 summer meeting have n

t been decided. The annual award of the Academy's nt-in-aid was made to Dr. E. R. Eller, of the Carie Museum, Pittsburgh, to finance his further search Scolecodonts. The following officers were elected: *President,* W. H. Thurston, Jr., Pennsylvania State llege; *President-elect,* E. A. Vuilleumier, Dickinson llege; *Vice-president* (western Pennsylvania), Anna Conn, Uniontown, (eastern Pennsylvania), Walter S. Lapp, Lansdale; *Secretary-Treasurer,* V. Earl Light, Lebanon Valley College; *Press Secretary,* Bradford Willard, Lehigh University; *Editor,* Robert T. Hance, Pittsburgh; *Junior Academy,* Karl F. Oerlein, California State Teachers College.

BRADFORD WILLARD,
Press-Secretary

SPECIAL ARTICLES

ISULFITE BINDING SUBSTANCES (B.B.S.) AND THIAMIN DEFICIENCY

THIAMIN plays an important role in the metabolism pyruvic acid. Keto-acids and aldehydes, including ruvic acid, react with bisulfite (and hence are med bisulfite binding substances—B.B.S.) affording basis for their determination.[1] Thompson and Johnn[2] found a marked increase in the quantity of B.S. in the blood of thiamin-deficient rats and eons. Estimations of pyruvic acid in the latter owed that the rise in B.B.S. was due almost entirely this substance. Lu[3] found a marked increase of ruvic acid in the blood of thiamin-deficient rats.

Adapting the technic of Clift and Cook[1] to urine we ve investigated further the relationship of B.B.S. d thiamin deficiency with the view to working out method of appraising the status of thiamin nutrition humans and as a means of estimating the content thiamin in foodstuffs and biological materials.

It was early found in working with rats that the antity of food intake is an important factor in the ults obtained. Consequently, the amount of food st be limited to an arbitrary level during urine lection periods. The addition of considerable NaCl the diet during collection periods assures sufficient ne so that animals can be studied individually. The t has no vitiating effects on the results.

There is a rapid and progressive rise in the urinary B.S. of young adult rats on a thiamin-deficient t. Frequently in as little as one week, after restricn to the diet, the increase is 200 to 400 per cent., nfirming the findings of Banerji and Harris[4] pubed while this study was in progress. In advanced iciencies the increase is as much as 600 to 900 per t. When the food intake is limited at a constant el and thiamin is given, the B.B.S. of deficient rats ps to normal within 24 hours. This effect is parly masked when food is given *ad libitum,* since thiamin quickly stimulates the appetite. In animals receiving the standardized level of the deficient diet, adequately supplemented with thiamin, consecutive daily B.B.S. values are within a narrow range, 3–8 ml (expressed as ml of 0.005 N iodine) per 24 hours.

It is generally recognized that high fat diets can prevent or cure polyneuritis in rats.[5,6] We have made some observations on this relationship, in connection with the effect of diet on B.B.S. values. When fat (autoclaved lard) is substituted isocalorically for sucrose in the thiamin-deficient diet, there is some immediate decrease in B.B.S., but the values remain high (300 to 400 per cent. above normal) with no further change even after feeding the fat for two weeks. During this interval the growth rate and appearance markedly improve. Thiamin administration causes a B.B.S. drop to normal within 24 hours. Control animals on the same schedule receiving adequate thiamin showed no change in B.B.S. It is hoped that our studies now in progress will contribute to a satisfactory interpretation of these results.

MAURICE SHILS
HARRY G. DAY
E. V. McCOLLUM
SCHOOL OF HYGIENE AND PUBLIC HEALTH,
THE JOHNS HOPKINS UNIVERSITY

[1] F. P. Clift and R. R. Cook, *Biochem. Jour.,* 26: 1788, 2.

[2] R. H. S. Thompson and R. E. Johnson, *Biochem. Jour.,* 694, 1935.

[3] G. D. Lu, *Biochem. Jour.,* 33: 774, 1939.

[4] G. G. Banerji and L. J. Harris, *Biochem. Jour.,* 33: 6, 1939.

[5] W. D. Salmon and J. G. Goodman, *Jour. Nutrition,* 13: 477, 1939.

[6] F. E. Stirn, A. Arnold and C. A. Elvehjem, *Jour. Nutrition,* 17: 485, 1939.

A NEW METHOD FOR STUDYING THE PROPERTIES OF LUBRICATING OILS BASED ON THE USE OF A NEW INSTRUMENT

WE have recently succeeded in making an automatic recording tensiometer. This instrument takes one measurement every two minutes, and being equipped with synchronous motors (of the electric clock type) will record the value of the surface tension practically indefinitely on a roll of paper. The recording box is connected to the tensiometer through an electric cable, so that the tensiometer itself can be placed in a separate room, an ice box, an incubator or even in a tightly closed chamber submitted to high pressure or vacuum.

This arrangement will make it possible to obtain measurements of surface tension under conditions never realized thus far, and to record variations occurring over long periods of time, during the process of biological reactions (fermentations, growth of bacteria, etc.) in an incubator, for instance.

We applied it first to the study of the properties of lubricating oils. A new technique had to be developed, inasmuch as the surface tension of pure oils fails to supply information concerning the presence of the polar groups to which the lubricating properties are due. An oil devoid of polar, adsorbable molecules, such as paraffin oil, does not become adsorbed on the metallic surfaces, and therefore constitutes a very bad lubricating oil. It has been shown by measurements of interfacial tension against water, by means of du Noüy interfacial tensiometer[1] that the addition of highly polar molecules, such as oleic or stearic acid, in small quantity, is sufficient to transform paraffin oil into a good lubricating oil.

In order to observe such changes which up to now could be detected only by variations in the interfacial tension, we experimented no longer on pure oils, but on a small quantity of water polluted by a trace of oil.

Records of the surface tension show that while the surface tension of paraffin oil is somewhat lower than that of the average motor oil, the surface tension of water polluted by oil is decreased (by a few dynes: 5 to 12) by the presence of motor oil, while it is unchanged by the presence of non-spreading paraffin oil.

If the surface of the polluted water is then touched with a thin glass rod previously dipped in oleic acid, the surface tension falls abruptly, no matter what oil is floating on the water. But thereafter, the records are quite different: in the case of paraffin oil, over a period of four or five hours, there is no rise in the surface tension, or, when the amount of oleic acid was extremely small, a slight and progressive increase, which may attain 3 to 8 dynes, is observed. In the case of a good lubricating oil, however, we observe a rise, which may attain 15 to 20 dynes within one or two hours; this rise follows a beautiful geometric curve (see Fig. 1).

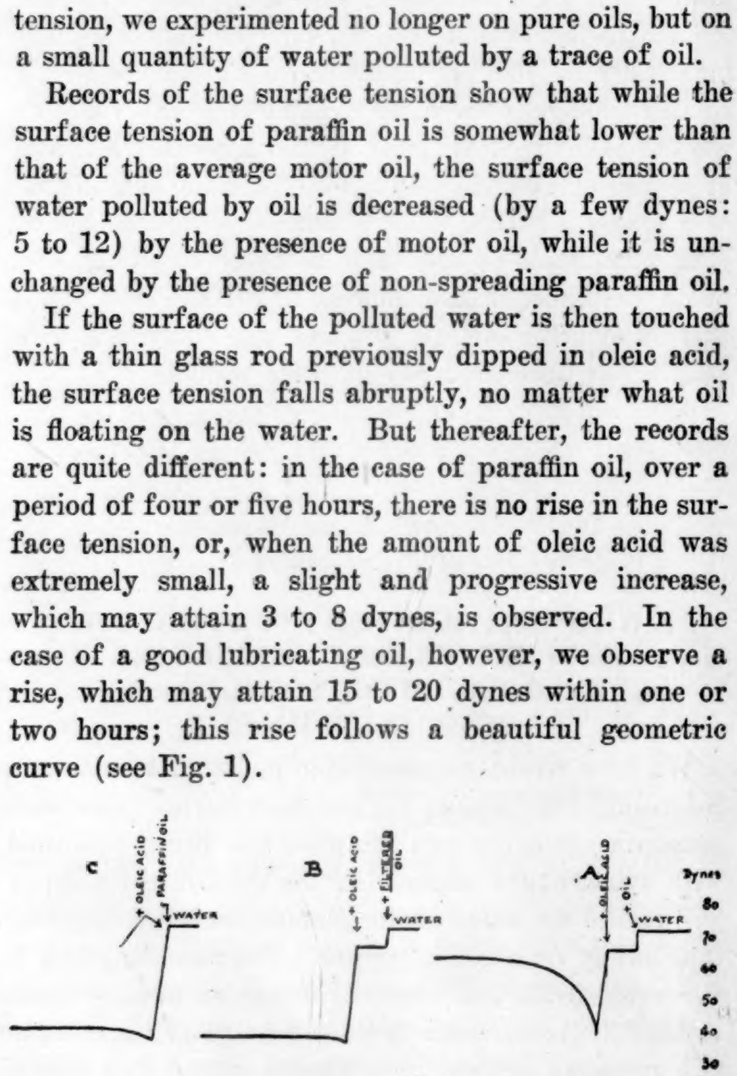

FIG. 1

[1] See J. J. Trillat, International Congress of Chemistry, Rome, 1938.

This phenomenon is apparently due to the adsorption of the polar molecules of oleic acid by the polar molecules of the oil. Should this be true, any process which would deprive a lubricating oil of its polar molecules, thereby decreasing its lubricating properties—such as filtration, for instance—should result in yielding an oil which would react to our test in the same way as paraffin oil. Fig. 1 shows that such is the case: Curve A is a record obtained with a good motor oil, unfiltered, while curve B is a record obtained with the same oil *after filtration* over four layers of filter paper. Curve C is obtained with paraffin oil.

This experiment shows definitely that filtration of lubricating oils is a dangerous process when the lubricating properties must be preserved. By means of interfacial measurements, J. J. Trillat had arrived at the same conclusions.

It seems safe to admit, tentatively, that this new phenomenon is very closely related to that which we described first in 1922 under the name of "antagonistic phenomenon."[2]

Of course, it would be possible, by means of an ordinary, non-recording tensiometer to perform the same experiments. But in order to obtain a perfect curve, it would require a large number of measurements of surface tension, over a period of hours, and this is a rather trying procedure.

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AUTOPHAGIA IN RATS TRAUMATIZED DURING INANITION[1]

IN an inanition experiment with male adult albino rats, during which the rats were wounded, 50 per cent. of the traumatized rats ate their bodies at the wounded areas. In none of the inanition experiments performed by the author in which the rats were not wounded has there been any evidence of autophagia.

Thirty male adult albino rats were placed in adjoining individual cages with wire screen walls of a mesh large enough for the penetration of the fore paws or the tip of the tail into the adjoining cage. All the rats were placed on a complete starvation diet, and one half of them were given an ample sufficiency of water at all times. Fourteen, or approximately one half, of the rats received wounds on their fore paws or tails, which occasionally penetrated the mesh of the wire screen between the cages and were bitten by their

[1] The investigation was initiated in the Department of Zoology of the University of Maryland, College Park, Maryland.

[2] Lecomte du Noüy, *Jour. Exp. Med.*, 36: 115, 1922, and "Surface Equilibria of Biological and Organic Colloids," (A. C. S. Monograph) New York, 1926, p. 155.

neighbor. Of the wounded rats, six were in the group which received neither food nor water, and eight were in the group which received water alone.

Fifty per cent. of the injured rats in both of the groups continued their own destruction by eating either their fore paws or their tails, depending upon which had been wounded. If the tail was eaten, the fore paws were left unmolested, whereas, if the fore paws were eaten, they were attacked simultaneously and removed somewhat symmetrically, while the tail was left undisturbed. In extreme cases of autophagia almost two inches of the tail was eaten and the fore-limbs were completely removed up to the elbows. The eaten parts were removed evenly leaving clean wounds which presented no evidences of infection. The autophagia was not completed in one meal but was continued over a period of several days, the rats apparently finally being halted in the autophagia by their extreme weakness, which was evidently due to their inability to secure sufficient nourishment from this source.

Since an equal proportion of injured starved rats in the group to which water was available and in the group which lacked a water supply, namely, 50 per cent., ate portions of their bodies, it appears that the availability of water did not affect the incidence of autophagia.

A control group of 15 male adult albino rats traumatized in the same manner while on a supermaintenance diet exhibited a tendency to mouth their wounds, but there were absolutely no evidences of autophagia. Since neither unwounded starved rats nor wounded well-fed rats eat themselves, and since 50 per cent. of the wounded starved rats practiced autophagia, it is evident that neither the hunger drive nor the desire to mouth the wounded areas is strong enough alone to produce autophagia, but that in combination the two drives were strong enough in 50 per cent. of the cases to cause the rat to eat the wounded member.

Evidently the starved traumatized rat is originally attracted to its wound by its desire to mouth it, and, when this occurs, the already existing hunger drive causes the rat, in 50 per cent. of the cases, to begin an actual eating process of the wounded member. Apparently the mouthing of the wounded area is a necessary stimulus to set off this process. It is possible that the 50 per cent. of the injured starved rats which failed to practice autophagia were wounded before the hunger drive was strong enough to induce autophagia, and that by the time the strength of the hunger drive had reached such a proportion, the desire to mouth the wounds had ceased to exist due to the lack of irritation at these places.

Carroll Blue Nash

University of Arizona

SCIENTIFIC APPARATUS AND LABORATORY METHODS

SOME USES OF VACUUM IN MICROLOGY

At the Columbus meetings of the American Association for the Advancement of Science we demonstrated some of the advantages that obtained through the carrying out of various micrological procedures under partial vacuum. The apparatus required is simple and can be put together from materials available in any biological laboratory. An ordinary filter pump is adequate for lowering the pressure. A motor-driven vacuum pump has been tried, but it must be closely watched to prevent the production of too high vacuum. The rather low partial vacuum that we have used has not been injurious to delicate tissues.

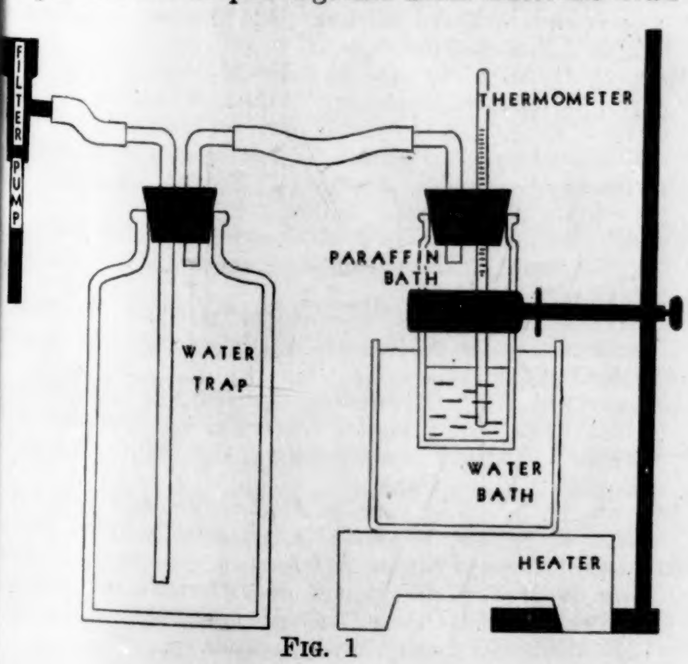

Fig. 1

The construction of the apparatus can be understood by referring to the diagrammatic figure.

The time required in the various solutions will vary with the size and density of the tissue. In general 15 to 30 minutes under vacuum will help the penetration of the killing agent, although the tissue should remain in this solution for several hours to complete fixation; 30 minutes will dehydrate the tissue when "Cellosolve" is used (tissue should be changed to fresh "Cellosolve" once during this time); 15 minutes in chloroform; 15 to 120 minutes in melted rubber-bees-wax-paraffin.[1]

Of particular value is the marked reduction of the time required for the infiltration of the tissue with the paraffin mixture and the automatic indication of the completion of this process. The chloroform used for clearing leaves the tissue in a stream of bubbles when

[1] R. T. Hance, Science, 77: 353, 1933.

placed in melted paraffin under partial vacuum. When the bubbling ceases, infiltration is complete. The short time required for infiltration of the paraffin makes it possible for the micrologist to watch and to control the temperature of the bath so that it is kept but a few degrees above the melting point of the paraffin.

Since the demonstration at Columbus our attention has been called to equipment for paraffin impregnation *in vacuo* listed in an English apparatus catalogue[2] and to a description by C. E. Moritz of equipment similar to that here described.[3]

Aside from the cost of the English apparatus it obviously has certain disadvantages not possessed by the outfit we use. The English vacuum imbedding oven is all metal, which prevents viewing the tissue during the process of infiltration. Since, as noted above, the cessation of the flow of bubbles from the tissue indicates that infiltration is complete, it is desirable to be able to constantly see the tissue. It can then be removed and blocked at once. The English apparatus reduces the pressure on the paraffin with a hand pump. We have found it advantageous to keep the paraffin bath on the pump throughout the period required for infiltration which serves to remove all traces of chloroform and other volatile fluids that may be introduced with the tissue. This results in a paraffin of superior texture for cutting.

Moritz has redescribed and added to technique developed by Lebowich in 1936.[4] He uses acetone for dehydration preparatory to infiltration with a soap-wax mixture.

Our equipment permits the ready application of pressure reduction not only to the processes of paraffin infiltration but to fixation, dehydration and clearing as well. The apparatus is so simple and inexpensive that one can be assigned to each pair of students.

ROBERT T. HANCE
RALPH L. CHERMOCK
DUQUESNE UNIVERSITY

A METHOD FOR PRESERVING TRYPANOSOMA EQUIPERDUM

TRYPANOSOMA EQUIPERDUM has been kept viable and infective for a period of fourteen months by freezing and storing infected rat blood in a dry ice alcohol bath. The procedure used in preserving the blood was as follows: Rat blood heavily infected with *T. equiperdum* was citrated with 0.2 per cent. sodium citrate or defibrinated by stirring with a sterile glass rod. Three to 5 cubic centimeters of the blood so treated were then introduced into a 50-cc sterile Pyrex vial. The vial was then stoppered with a sterile one-hole rubber cork into which a glass rod one foot long had been inserted. The vial was then lowered into the freezing bath of dry ice and alcohol, rapidly twirling it during and after submersion by rolling the glass rod back and forth between the palms of the hands. The blood froze almost instantaneously in the form of a thin thimble in the bottom of the vial. The cork and rod were then removed without removal of the bottom of the vial from the bath. A new sterile aproned rubber cork was then inserted into the vial and the apron of the cork turned down and securely fastened with rubber bands. The vial was then allowed to submerge in the dry ice alcohol bath. Sixteen vials of infected rat blood were prepared in this manner.

The bath used was a wide-mouthed thermos bottle of five gallons capacity into which two gallons of ethyl alcohol and twenty pounds of dry ice had been placed. Additions of dry ice were made once to twice weekly to maintain the bath.

The viability of the trypanosomes was tested after forty-six days and after fourteen months by removing vials from the dry ice bath and allowing them to thaw either at room temperature or by submersion in cold tap water. The blood, when thawed, was hemolyzed but actively motile trypanosomes were present and on inoculation into young white rats produced fatal infections of *T. equiperdum* which could be transmitted in series.

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[2] Charles Hearson and Co., Catalogue, London, England.
[3] C. E. Moritz, *Stain Tech.*, 14: 17–20, 1939.
[4] R. J. Lebowich, *Arch. Path.*, 22: 782–805, 1936.

BOOKS RECEIVED

BELCHER, J. E. and J. C. COLBERT. *Experiments and Problems for College Chemistry.* Third edition. Pp. viii + 207. 17 figures. $1.75. *Properties and Numerical Relationships of the Common Elements and Compounds.* Third edition. Pp. ix + 350. 34 figures. $2.00. Appleton-Century.

BOTLEY, C. M. *The Air and Its Mysteries.* Pp. xvi + 302. 33 figures, 19 plates. Appleton-Century. $3.00.

CHAMOT, E. M. and C. W. MASON. *Handbook of Chemical Microscopy. Vol. II. Chemical Methods and Inorganic Qualitative Analysis.* Second edition. Pp. xi + 438. 233 figures. Wiley. $5.00.

Comité National Français et Comité National Marocain de Géodésie et Géophysique, Année, 1938. Pp. 148. Le Comité, Paris.

CRUMPLER, THOMAS B. and JOHN H. YOE. *Chemical Computations and Errors.* Pp. xiv + 247. 16 figures. Wiley. $3.00.

HELBRONNER, P. *Description Géométrique detaillee des Alpes Françaises; Tables Générales des Quatorze Éléments.* Extrait du Tome XII. Pp. 355–1192. Gauthier-Villars, Paris.

REASON, H. A. *The Road to Modern Science.* Pp. xiv + 297. 43 figures, 33 plates. Appleton-Century. $3.00.

RIEZLER, KURT. *Physics and Reality. Lectures of Aristotle on Modern Physics at an International Congress of Science, 679 Olymp. Cambridge, 1940 A.D.* Pp. 124. Yale University Press. $2.00.